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Patent claims

1.
A control system for controlling the shielding gas supply to a wire welding apparatus, which wire welding apparatus has a wire feed device (106) having a feed signal output which is indicative of a wire feeding speed (U), which wire welding apparatus is connected to a gas tank (101) via a gas supply line (210, 202), in which supply line there may according to choice be arranged a pressure regulator (102) and a manometer (103), characterised in that the control system comprises
a controllable gas flow valve (110) having a valve inlet, a valve outlet and a valve control signal input;
a gas flow sensor (111) having a gas inlet, a gas outlet and a sensor signal output; and
a programmable control circuit (112) having a first and a second input and a first output, wherein the gas tank has an inlet connection (201, 202) to the valve inlet, the valve outlet has a valve outlet connection (207) to the gas inlet, the gas outlet has a gas outlet connection (208) to a shielding gas outlet, the feed signal output has a feed signal connection (203) to the first input, the sensor signal output has a sensor signal connection (205) to the second input, the control signal output has a control signal connection (206) to the valve control signal input, and
the programmable control circuit comprises a processor which, in accordance with at least one program in a first memory in the control circuit, and on the basis of signals received at the first and second inputs, provides at the first output a valve control signal (Q), which valve control signal is adjustable within a dynamic range of values limited by a predetermined minimum value (Qmin) and a predetermined maximum value (Qmax).

2.
A control system as disclosed in claim 1, characterised in that the programmable control circuit has a third input, which third input is a communications port for the transfer of the at least one program from a programming device (113), via a communication connection (204), to the memory.

3.
A control system as disclosed in claim 1 or 2, characterised in that the program comprises at least one instruction to the processor instructing the processor to issue the valve control signal as a signal that is proportional to a signal representing the difference between the signal at the first input and the signal at the second input.

4.

A control system as disclosed in claim 1 or 2, characterised in that the program comprises at least one instruction to the processor instructing the processor to issue the valve control signal as a signal that is proportional to a signal representing the difference between the signal at the first input and the signal at the second input, proportional to a signal representing a time integral of the difference between the signal at the first input and the signal at the second input, and proportional to a signal representing a time derivative of the difference between the signal at the first input and the signal at the second input.

5.

A control system as disclosed in any one of the preceding claims, characterised in that the program comprises at least one instruction to the processor instructing the processor, from the time the signal at the first input exceeds a first threshold value (Uth1) and in an immediately subsequent first predetermined time period, to issue at the first output a single signal that is constant and having a value which corresponds substantially to the minimum value (Qmin).

6.

A control system as disclosed in any one of the preceding claims, characterised in that the control circuit comprises a second memory arranged to continuously register the signal value at the first output; and

that the program comprises at least one instruction to the processor instructing the processor, from the time the signal at the first input falls short of a second threshold value (Uth2) and in an immediately subsequent second predetermined time period, to issue at the first output a single signal that is constant and having a value that substantially corresponds to the signal value at the time, or immediately prior to the time, when the signal at the first input fell short of the second threshold value.

7.

A control system as disclosed in any one of the preceding claims, characterised in that the first threshold value (Uth1) is equal to the second threshold value (Uth2).

8.

A control system as disclosed in any one of claims 3, 4, 5, 6 and 7,

characterised in that the control circuit comprises a control parameter register for storing at least one of the minimum value (Qmin), the maximum value (Qmax), the first threshold value (Uth1), the second threshold value (Uth2), a wire feeding speed minimum threshold (Umin) and a wire feeding speed maximum threshold (Umax), that the program comprises at least one instruction to the processor instructing the processor to set the proportionality so that the control circuit at the first output issues the minimum value (Qmin) when the wire feeding speed (U) corresponds to the wire feeding speed minimum threshold (Umin) and the maximum value (Qmax) when the wire feeding speed (U) corresponds to the wire feeding speed maximum threshold (Umax); and
that the program comprises at least one instruction to the processor instructing the processor to issue at the first output the minimum value (Qmin) when the wire feeding speed (U) is below the wire feeding speed minimum threshold (Umin) and the maximum value (Qmax) when the wire feeding speed (U) is above the wire feeding speed maximum threshold (Umax).

9.
A control system as disclosed in any one of the preceding claims,
characterised in that the programmable control circuit has a second output, which second output issues a warning signal when the first output issues the minimum value (Qmin) or when the wire feeding speed (U) is equal to or lower than the wire feeding speed minimum threshold (Umin).

10.
A control system as disclosed in any one of the preceding claims,
characterised in that the programmable control circuit has a second output, which second output issues a warning signal when the first output issues the maximum value (Qmax) or when the wire feeding speed (U) is equal to or higher than the wire feeding speed maximum threshold (Umax).

11.
A control system as disclosed in any one of claims 2 - 10,
characterised in that the communications port is also arranged for the transfer of control parameters from the programming device (113), via the communication connection (204), to the programmable control circuit.

12.
A control system as disclosed in any one of claims 2 - 11, characterised in that the communications port is also arranged for the transfer between the programming device and the programmable control circuit of data stored in, or for storage in, the parameter register and of data representing at least one of a valve control signal (Q), a wire feeding speed (U), and a warning signal.

13.
A control system as disclosed in any one of claims 2 - 12, characterised in that the programming device comprises a user interface for the input of control parameters and for the display of data transferred to and from the programmable control circuit.

14.
A control system as disclosed in any one of claims 2 - 13, characterised in that the programming device is a personal computer (PC).

15.
A method for controlling shielding gas supply to a wire welding apparatus connected to a gas tank (101) via a gas supply line (210, 202) in which supply line there may according to choice be arranged a pressure regulator (102) and a manometer (103), which wire welding apparatus comprises a wire feed device (106) having a feed signal output which is indicative of a wire feeding speed (U), a controllable gas flow valve (110) having a valve inlet, a valve outlet and a valve control signal input, a gas flow sensor (111) having a gas inlet, a gas outlet and a sensor signal output, and a programmable control circuit (112) having a first and a second input and a first output, where the gas tank has an inlet connection (201, 202) to the valve inlet, the valve outlet has a valve outlet connection (207) to the gas inlet, the gas outlet has a gas outlet connection (208) to a shielding gas outlet, the feed signal output has a feed signal connection (203) to the first input, the sensor signal output has a sensor signal connection (205) to the second input, the control signal output has a control signal connection (206) to the valve control signal input, and the programmable control circuit comprises a processor which, in accordance with at least one program in a first memory in the control circuit, and on the basis of signals received at the first and second inputs, provides at the first output a valve control signal (Q), which valve control signal has a dynamic range of values limited by a predetermined minimum value (Qmin) and a predetermined maximum value (Qmax),

characterised by
issuing the valve control signal in the form of a signal that is proportional to a signal representing the difference between the signal at the first input and the signal at the second input.

16.
A method for controlling shielding gas supply to a wire welding apparatus connected to a gas tank (101) via a gas supply line (210, 202) in which supply line there may according to choice be arranged a pressure regulator (102) and a manometer (103), which wire welding apparatus comprises a wire feed device (106) having a feed signal output which is indicative of a wire feeding speed (U), a controllable gas flow valve (110) having a valve inlet, a valve outlet and a valve control signal input, a gas flow sensor (111) having a gas inlet, a gas outlet and a sensor signal output, and a programmable control circuit (112) having a first and a second input and a first output, where the gas tank has an inlet connection (201, 202) to the valve inlet, the valve outlet has a valve outlet connection (207) to the gas inlet, the gas outlet has a gas outlet connection (208) to a shielding gas outlet, the feed signal output has a feed signal connection (203) to the first input, the sensor signal output has a sensor signal connection (205) to the second input, the control signal output has a control signal connection (206) to the valve control signal input, and the programmable control circuit comprises a processor which, in accordance with at least one program in a first memory in the control circuit, and on the basis of signals received at the first and second inputs, provides at the first output a valve control signal (Q), which valve control signal has a dynamic range of values limited by a predetermined minimum value (Qmin) and a predetermined maximum value (Qmax),
characterised by
issuing the valve control signal in the form of a signal that is proportional to a signal representing the difference between the signal at the first input and the signal at the second input, proportional to a signal representing a time integral of the difference between the signal at the first input and the signal at the second input, and proportional to a signal representing a time derivative of the difference between the signal at the first input and the signal at the second input.

17.
A method as disclosed in claim 15 or 16, characterised by issuing at the first output, from the time the signal at the first input exceeds a first threshold value (Uth1) and in an

immediately subsequent first predetermined time period, a single signal that is constant and having a value which corresponds substantially to the minimum value (Qmin).

18.

A method as disclosed in claim 15 or 16, characterised by giving at the first output, from the time the signal at the first input falls short of a second threshold value (Uth2) and in an immediately subsequent second predetermined time period, a single signal that is constant and having a value that substantially corresponds to the signal value at the time, or immediately prior to the time, when the signal at the first input fell short of the second threshold value.

19.

A method as disclosed in one of claims 17 or 18, characterised in that the first threshold value (Uth1) is equal to the second threshold value (Uth2).

20.

A method as disclosed in one of claims 15-19, characterised by storing in a control parameter register in the control circuit at least one of the minimum value (Qmin), the maximum value (Qmax), the first threshold value (Uth1), the second threshold value (Uth2), a wire feeding speed minimum threshold (Umin) and a wire feeding speed maximum threshold (Umax);
setting the proportionality so that the control circuit at the first output issues the minimum value (Qmin) when the wire feeding speed (U) corresponds to the wire feeding speed minimum threshold (Umin) and the maximum value (Qmax) when the wire feeding speed (U) corresponds to the wire feeding speed maximum threshold (Umax); and
by issuing at the first output the minimum value (Qmin) when the wire feeding speed (U) is below the wire feeding speed minimum threshold (Umin) and the maximum value (Qmax) when the wire feeding speed (U) is above the wire feeding speed maximum threshold (Umax).

21.

A method as disclosed in one of claims 15 or 16, characterised by issuing at a second output of the programmable control circuit a warning signal when the first output issues the minimum value (Qmin) or when the wire feeding speed (U) is equal to or lower than the wire feeding speed minimum threshold (Umin), or a warning signal when the first

output issues the maximum value (Qmax) or when the wire feeding speed (U) is equal to or higher than the wire feeding speed maximum threshold (Umax).

22.

A method as disclosed in one of claims 15 - 21, characterised by transferring control parameters, from a programming device (113), via a communication connection (204), to the programmable control circuit.

23.

A method as disclosed in one of claims 15-21, characterised by transferring between a programming device (113) and the programmable control circuit, via a communication connection (204), data stored in, or for storage in, the parameter register, and data representing at least one of a valve control signal (Q), a wire feeding speed (U), and a warning signal.

24.

A method as disclosed in claim 23, characterised by entering control parameters and by displaying data transferred to and from the programmable control circuit, by means of a user interface in the programming device.

25.

A method as disclosed in one of claims 22 - 24, characterised in that the programming device is a personal computer (PC).

26.

A welding apparatus, characterised in that it comprises a control system according to any one of patent claims 1-14.